



Moving Ahead with a New Nuclear Age

*Office of Nuclear Energy, Science and Technology
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Introduction

The demand for energy in the United States is rising much faster than the projected increase in domestic energy production. The shortfall between domestic energy demand and domestic supply is projected to increase nearly 50 percent by 2020. That projected shortfall can be made up in only three ways – import more energy, improve energy conservation and efficiency, and/or increase domestic supply.

The Administration considered these options in its development of the National Energy Policy (NEP). It concluded that increased dependence on oil imports from volatile regions of the world would jeopardize our national and economic security. As imports rise, so does our vulnerability to price shocks, shortages, and disruptions. For that reason, the Administration resolved to take steps to improve energy conservation and efficiency, increase domestic energy production, and increase the reliability and security of imports in order to avoid increased dependence on imports from volatile regions of the world.

Largely consistent with the priorities set forth in the NEP, the President signed the Energy Policy Act (EPACT) into law in August 2005. This law is the first comprehensive energy plan in more than a decade. As well as encouraging energy efficiency and conservation and promoting alternative and renewable energy sources, it encourages the expansion of nuclear energy in the United States.

The benefits of nuclear power as a safe, reliable, and affordable source of energy are an essential element in the Nation's energy and environment future. Nuclear power has become the second most abundant source of electric energy in the United States, and existing plants are among the most economic sources of electricity on the grid today. The Office of Nuclear Energy, Science and

Technology (NE) focuses on the development of advanced nuclear technologies to assure diversity in the U.S. energy supply. These activities support the Department's goal to develop new generation capacity to fortify U.S. energy independence and security, while making improvements in environmental quality. Further, they build on important work started over the last three years to deploy new nuclear plants in the U.S. by early in the next decade, and to develop advanced, next generation nuclear technology.

NE leads the development of new nuclear energy generation technologies to meet energy and climate goals and advanced, proliferation-resistant nuclear fuel technologies that maximize energy from nuclear fuel, while maintaining and enhancing the national nuclear infrastructure.

Nuclear Energy R&D

As the United States considers the expansion of nuclear energy, it is clear that the Nation must optimize its approach to managing used nuclear fuel. While the planned geologic repository at Yucca Mountain would be sufficient for all commercial spent fuel generated in the United States through 2015, the current "once-through" approach to spent fuel will require the United States to build additional repository space to assure the continued, safe management of nuclear waste from currently operating plants and a new generation of nuclear plants. Further, long-term issues associated with the radiotoxicity of nuclear waste and the eventual proliferation risks posed by plutonium in spent fuel remain.

The **Advanced Fuel Cycle Initiative (AFCI)** is focused on developing technologies that can reduce the volume and long-term toxicity of high level waste from used nuclear fuel, reduce the

long-term proliferation threat posed by civilian inventories of plutonium in spent fuel, and provide for proliferation-resistant technologies to recover the energy content in used nuclear fuel. Currently, the used nuclear fuel at nuclear plant sites contains the potential energy equivalent of 6 billion barrels of oil, or about two full years of U.S. oil imports. The AFCI program will make it possible to establish an improved, optimized nuclear fuel cycle that will turn this waste into a huge source of energy and do so in a manner that improves the long-term proliferation-resistance of the civilian nuclear fuel cycle.

The **Global Nuclear Energy Partnership (GNEP)** will accelerate the work being done under the AFCI program. Advanced recycling technologies can extract highly radioactive elements of commercial spent nuclear fuel and use that material as fuel in fast spectrum reactors to generate additional electricity. The extracted material, which includes all transuranic elements (e.g., plutonium, neptunium, americium and curium), would be consumed by fast reactors to reduce significantly the quantity of material requiring disposal in a repository and to produce power. The plutonium would remain bound with other highly radioactive isotopes, thereby preserving its proliferation resistance and reducing security concerns. With the transuranic materials separated and used for fuel, the volume of waste that would require disposal in a repository would be reduced by 80 percent.

Improving the way spent nuclear fuel is managed in this manner will facilitate the expansion of civilian nuclear power in the United States and encourage civilian nuclear power in foreign countries to evolve in a more proliferation-resistant manner. Once these recycling technologies are proven, the United States and other countries having the established infrastructure could arrange to supply nuclear fuel to countries seeking the energy benefits of civilian nuclear power, and the spent nuclear fuel could be returned to partner countries for eventual disposal in international repositories. In this way, foreign countries could

obtain the benefits of nuclear energy without needing to design, build, and operate uranium enrichment or recycling technologies to process and store the waste.

The advanced research conducted under AFCI and GNEP, if successful, will enable us to extend the useful life of the Yucca Mountain repository almost indefinitely and reduce the radiotoxicity of the wastes it contains from more than 100,000 years to less than 1,000 years. This technology will also allow nuclear plants to exploit a far higher fraction of the energy contained in uranium ore—expanding the lifetime of the world's nuclear fuel resources from around 100 years up to 1000 years.

The development of these advanced technologies is also critical to the construction of new nuclear power plants in the United States. Today, United States utilities operate 103 nuclear power reactors. These facilities quietly and efficiently provide one-fifth of the Nation's electricity. These plants do not emit carbon, operate year-round in all weather conditions, and produce the least expensive power on the grid today (other than hydroelectric dams).

Over the last 15 years, utilities in the United States have become the best operators of nuclear power plants in the world. U.S. plants, which were available to produce energy only 70 percent of the time on average in the early 1990s, are now producing power around 92 percent of the time. More efficient operation has allowed nuclear plant operators to produce more energy than ever before, adding the equivalent of nearly 10 new nuclear plants to the U.S. grid through efficiency improvements.

Consolidation of plant ownership to a fewer number of excellent operators has made the operation of U.S. plants safer than ever, more cost-effective, and more reliable than ever. As a result of this success, essentially all U.S. nuclear plants are expected to apply for renewed licenses that will keep most plants in operation into the middle of the century. The Tennessee Valley Authority (TVA) is going a step further and rebuilding a plant that was abandoned in 1985. TVA expects to invest \$1.8 billion to bring this 1200 megawatt plant on-line by 2007.

Buoyed by this success, industry is seriously considering building the first new nuclear power plants in the United States since the early 1970s. The Department of Energy (DOE) is encouraging this new interest in nuclear energy through its **Nuclear Power 2010** program. This program's basic missions are to cost-share with industry to demonstrate untested Nuclear Regulatory Commission licensing processes, find sites on which to build new plants, and certify state-of-the-art (or "Generation III+") designs for new nuclear power plants. The program also conducts economic studies and analyses that help point to the barriers facing the construction of new plants.

While it is still rather early, this program is proving to be very successful. Three utilities are cooperating with DOE to obtain Early Site Permits for their preferred sites—the first time this important regulatory tool has ever been used. Once done, these utilities will have sites that are pre-approved by regulators to host new plants. This process will avoid the problems in siting that vastly escalated the cost of some plants in the 1980s and led to the abandonment of others (most notably the Shoreham plant in New York).

In FY 2005, the Department established two competitively selected, cost-shared cooperative agreements with industry consortia to obtain combined Construction and Operating Licenses (COLs). The COL process is a "one-step licensing" process established by the EPACT of 1992 and intended to resolve all public health and safety issues associated with the construction and operation of a new nuclear power plant before construction begins. The work of the two utility-led consortia includes design certification and completion of state-of-the-art Generation III+ nuclear plant designs for Westinghouse's Advanced Pressurized Water Reactor (AP1000) and General Electric's Economic and Simplified Boiling Water Reactor (ESBWR); and site-specific analysis and engineering required to obtain COLs from the Nuclear Regulatory Commission.

However, for new plants to be built in the United States, it is essential that we deal with the financial barriers facing new nuclear power plant projects. The EPACT of 2005 directs the Secretary to establish a program to provide standby support contracts for six new advanced nuclear energy

reactors. In FY 2006, the Department will issue a notice of final rulemaking for the regulation of standby support contracts for new nuclear plants in accordance with the requirements of the EPACT. In FY 2007, the Department will develop criteria and the process to accept, evaluate, and approve applications for these contracts.

The need to deal with these early plant costs is expected to become a central issue for the industry as the Nuclear Power 2010 program addresses the institutional barriers. Without the construction of new plants, the contribution of nuclear power to our energy picture will steadily decline as energy use increases and production of electricity from nuclear power stagnates. In addition to the erosion of the Nation's success strategy of maintaining a diversified energy supply, the decline of nuclear power will exacerbate U.S. efforts to improve the environment—nuclear power today comprises over 75% of all the non-emitting power generation in the country.

While current nuclear power plants provide an economically and publicly acceptable electricity supply in many markets, further advances in nuclear energy system design can broaden the opportunities for the use of nuclear energy.

The Department of Energy and the research agencies of many other countries are working together under the auspices of the U.S.-led Generation IV International Forum (GIF). This group has evaluated more than 100 concepts for advanced, next-generation nuclear power plants and selected six for further joint research and development. We continue to support research and development of next generation reactors through the **Generation IV Nuclear Energy Systems Initiative** program that could help achieve the desired goals of sustainability, improved economics, and proliferation resistance. Further investigation of technical and economic challenges and risks, including waste products, will help inform a decision on whether to proceed with a demonstration Next Generation Nuclear Plant, which would use very high temperature reactor technologies to economically produce both electricity and hydrogen gas. Key to the strategy for conducting all Generation IV research and

development is the multiplication effect derived from international collaboration. By coordinating U.S. efforts with those of the GIF partner nations, our funding is leveraged by a factor of two to ten, depending on the reactor concept involved.

Alongside the Generation IV Nuclear Energy Systems Initiative program, DOE is pursuing the **Nuclear Hydrogen Initiative**, which is developing advanced, high efficiency hydrogen production technologies that are tailor-made for the very high temperature heat that Next Generation Nuclear Plants will produce.

Early estimates indicate that a single Generation IV nuclear plant could produce the hydrogen equivalent of 160,000 gallons of gasoline each day at a competitive cost. As envisioned by the President in his National Hydrogen Fuel Initiative, this technology could pave the way for the commercial production of clean-burning hydrogen for transportation purposes—reducing our reliance on imported fossil fuels and making a real difference in the Nation’s production of carbon dioxide. It is possible to demonstrate these technologies on a commercial scale by mid-to-late next decade.

Maintaining the Nation’s Nuclear Infrastructure

In addition to nuclear research and development programs, the Department has the responsibility to maintain and enhance the Nation’s nuclear science and technology infrastructure.

In FY 2005, the Department created the Idaho National Laboratory (INL) to serve as the center for the Department’s nuclear energy research and development efforts. The INL will play a lead role in Generation IV nuclear energy systems development, advanced fuel cycle development, testing of naval reactor fuels and reactor core components, and space nuclear power applications. While the laboratory has transitioned its research and development focus to nuclear energy programs, it is also maintaining its multi-program national laboratory status to serve a variety of current and planned Department and national research and development missions.

DOE operates one of the world’s most comprehensive research infrastructures—much of which was constructed in the 1950s and 1960s. The Idaho Facilities Management program maintains the Department’s facilities at Idaho in a safe, secure and environmentally compliant condition for a range of vital Federal missions. The Idaho Site-wide Safeguards and Security program supports activities that are required to protect the Department’s Idaho complex assets from theft, diversion, sabotage, espionage, unauthorized access, compromise, and other hostile acts that may cause unacceptable adverse impacts on national security, program continuity, the health and safety of employees, the public, or the environment.

In addition, in FY 2007, the Department proposes to continue to provide fresh nuclear fuel and take back spent fuel from university research reactors. As such, the Department funds the fabrication of new fuel, shipments of fresh fuel, and shipments of spent fuel to DOE sites. This includes shipment of fuel that results from core conversions.

Conclusion

A plentiful, reliable supply of energy is the cornerstone of sustained economic growth and prosperity. Our Nation cannot and should not rely on any single energy technology to secure its future. A broadly diverse energy supply has sustained the country in the past and it must be available for the future. Nuclear energy is part of that diverse portfolio. It can serve us well and safely, as we require more energy to supply our growing economy while protecting the environment and enhancing America’s energy independence.

The role of the Department of Energy is to work with the private sector, our overseas partners, and other agencies to assure that the benefits of nuclear technology continue to benefit the security and quality of life for Americans—and other citizens of the world—now and into the future.